First Report on SWAM99 Workshop

A. Tolstoy
A Tolstoy Sciences
8610 Battailles Court
Annandale VA 22003
phone: (703) 978-5801 fax: (703) 978-1319 email: atolstoy@ieee.org
and
Kevin B. Smith
Department of Physics
Naval Postgraduate School
Monterey, CA 93943
phone: (831) 656-2107 fax: (831) 656-2834 email: kevin@physics.nps.navy.mil
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LONG TERM GOAL

The long term intent of this workshop is to predict the accuracy of any given acoustic propagation model in shallow water. Such models will be integral components of larger codes to be used for target detection, localization, and identification in range-dependent scenarios.

OBJECTIVES

The immediate objective of this workshop was to examine present propagation models (see Jensen et al., '94): adiabatic and coupled normal codes (such as KRAKEN and ORCA), Parabolic Equation (PE) codes, Ray based codes, and newly developed codes, within the context of shallow water *range-variable* environments (see Tolstoy et al., '98 for a workshop on range-*in*dependent benchmarking). A number of test cases (six cases: three with five subcases, two with three subcases, and one with no subcases for a total of twenty-two subcases) were devised which were proposed to the workshop participants to be worked on in advance. However, no "benchmark" solutions, i.e., answers, were computed since there was little agreement in advance on what would constitute such solutions in the absence of *analytic* solutions. Our intent was to:

- examine the performance of a variety of models under a variety of shallow water scenarios;
- compare their results;
- attempt to interpret model reliability based on inter-comparisons with the other model results and with other validation efforts, e.g., benchmarking a model relative to an ideal wedge as was done in Jensen and Ferla, '90.

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APPROACH

Various cases were devised to provide tests for a *wide range* of model applications. They included environments for which:

- the bottom properties (but not topography) varied in range;
- the bottom properties *and* topography varied in range (generally *up* or *down* a "slope");
- the environment varied in 3-D (subcases of: a wedge, a canyon, and a laboratory simulation devised by Stewart Glegg);
- the water sound-speeds varied to mimic internal wave situations (sinusoidal profile, soliton, and soliton plus linear perturbations);
- a final case simulating a shelf-break front with varying topography and sound-speed.

The participants were asked to apply their codes to the problems of interest to them with Transmission Loss (TL) files of the output supplied to K. Smith for plotting in a common format at the meeting. All participants were given exact environmental parameter inputs for their models. Thus, the only variations expected would be the result of model computations and user manipulation, *not* the result of uncertainties in parameters.

WORK COMPLETED

The workshop was held in Monterey Sep 8-9 and was attended by 30-35 researchers with approximately 25 presentations. Presenters are now preparing papers for submission to either a book of papers (to be published by Springer) or a Special Issue of a journal (such as J. Computat. Acoust. or IEEE J. Oceanic Eng.) to appear in 2000.

ACCOMPLISHMENTS AND RESULTS

We noted in the workshop presentations of the test cases that the results varied extensively, i.e., many 10s of dBs. The *wide* variation of results suggests that the execution of propagation models – even *given* exact input parameters such as sound-speed profiles in the bottom – is *non-trivial.* All the participants were experienced with their models, but there are still uncertainties as to why there were such significant discrepancies in the results. A few of the participants did offer consistent results, e.g., Dave Knobles, Peter Nielsen, Gary Brooke, and Dmitri Mikhin. Unfortunately, they did not *all* work on the *same* test cases.

A primary conclusion was that: future efforts will offer a clear calibration case such as the original benchmark wedge (Jensen and Ferla, JASA '90) *and* one of the newer test cases designed for this workshop and fully examined via coupled normal modes and PE modeling. It is hoped that such range-dependent calibration cases will help to orient users and add confidence that any particular model is performing accurately on other, more complicated

scenarios. As things stand now, there is plenty of room for uncertainty as to why there were such enormous variations in predicted computations. In general, such disparities are often found in fleet embedded models suggesting that it is *not* easy to make a prediction with present propagation codes.

Numerous *new* models and approaches were presented. These new codes indicate ongoing efforts to improve speed and efficiency in shallow water propagation modeling, and they will continue. More development along those lines is needed and expected.

It was also found that *reciprocity* can also be an effective second level test to add more believability to results. Its absence will indicate possible problem areas. Its presence will bolster model confidence.

Interpolation, particularly for environmental inputs, was found to be *crucial* to the quantitative results. This became very evident in the treatment of bottom properties which may generally be given only sparsely, particularly in the context of sea test measurements.

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